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DESCRIPTION

The work shall consist of removing, rehabilitating, furnishing, and installing all operating machinery. Included is the installation of electrical equipment, such as brakes, brake wheels, motors, limit switches and position transmitters to be mounted with machinery but supplied under electrical work. This work shall be coordinated with other work being performed on the project.

Demolishing of existing machinery components as shown on the plans is included within this work.

The contractor shall furnish, install, align, lubricate, test, paint, and place in satisfactory operating condition all new and refurbished operating machinery systems and components for each lift bridge as follows:

- Refurbished machinery shall consist of :
  - Idler sheaves

- Fabricated machinery including:
  - Shafts and Pins
  - Rack and Pinion Gears
  - B1, B4 and B5 Bearings for Ingersol Street Bridge
  - B1 and B4 for Washington Street Bridge
  - Operating Rope Sheaves
  - Machinery Supports
  - Thrust Rollers
  - Safety Guards
  - Brackets
  - Turned Bolts

- Commercially manufactured items including:
  - Speed Reducer
  - Couplings
  - Spherical Roller Bearings
  - All necessary fasteners, keys, shims, lifting eye bolts, spare parts, etc.

- Furnished and wired under “Electrical Work” but installed and aligned on the machinery supports including:
  - Motors
  - Brakes
  - Brake Wheels
  - Limit Switches
  - Speed Sensors

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- These item shall also include shop assembly of coupling hubs, motor and machinery brake wheels on their shafts. Those requiring disassembly for field installation shall be match marked.

- Miscellaneous items to be furnished including:

  Lubricants for bearings, gears, speed reducers, couplings, and all other components specified herein as required.

  Tools with Storage Cabinet.

  Grease gun, grease loader, and grease for all items requiring grease. Two grease guns will be provided for each type of grease required.

  Paint.

  Documentation for submittals, including shop drawings, catalog cuts of purchased equipment, certified drawings, procedures and manuals.

- All new components and assemblies shall be shop and/or field painted as specified herein.

MATERIALS

1. Speed Reducers

The speed reducers shall be of the parallel shaft type with all gearing of double helical or herringbone configuration. The speed reducers shall be manufactured in accordance with the current requirements of the American Gear Manufacturer's Association (AGMA). Speed reducers shall be standard models from one manufacturer, with ratios, dimensions, construction details, and AGMA ratings as shown on the Plans. Ratings shall be based on a service factor of 1.0.

The AGMA strength rating shall be based on a torque equal to 300 percent of full-load motor torque. Spur gears shall have helical or herringbone teeth, bearings shall be anti-friction type, and housings shall be welded steel plate or steel castings. The inside of the housings shall be sandblast cleaned prior to assembly and be protected from rusting. Exact ratios shall be furnished where specified.

Gearing in enclosed factory assembled speed reducers shall be thru-hardened and shall conform to AGMA Quality Number 8 or higher. Case-hardened gears shall not be used in speed reducers of the span drive.

Speed reducers are to be designed so as to meet all requirements of AGMA Standard 6010-E88 for the minimum rating indicated on the Contract Drawings at a service factor of 1.0. In addition, no component or element of the speed reducer shall be stressed to more than 75 percent of the material yield strength at 285 percent of the required minimum output torque rating.

Reducers shall be manufactured in accordance with the requirements of the AGMA and shall have nameplates giving the rated horsepower, ration, speed, service factor, and AGMA symbols.

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The unit for the Ingersoll Street lift bridge shall be rated for 20 hp, 870 rpm input, AGMA service factor of 1.0 with a ratio of 129.7:1.

The unit for the Washington Street lift bridge will be rated for a minimum of 25 hp, 870 rpm input, AGMA service factor 1.0, with a ratio of 129.7:1.

All instrumentation speed reducers shall have the requirements stated on the Plans.

The gear reducers shall be designed to operate over a temperature range of -34°C to 66°C (-30°F to 150°F).

Both units shall have a minimum single high speed shaft and a single low speed shaft. The non-driving side of the low speed shaft, or intermediate shafts, shall be modified for instrument shaft extensions as shown on the plans.

All shafts shall be mounted on anti-friction bearings with a B-10 life rating of not less than 40,000 hours at full rated speed and power.

Lubrication of the gears and bearings shall be automatic when the unit is in operation.

It is preferable that a bath lubrication system be utilized. In a bath lubrication system, all components in the reducer, which require lubrication, are partially submerged in the oil bath.

When the configuration of gears and bearings prevent bath lubrication, a splash lubrication system should be used. Splash lubrication systems shall continuously lubricate all gears and bearings property. Oil feed troughs may be used to supply oil to bearings, and gears, which are above the bath. Splash lubrication systems shall be designed such that equal lubrication is supplied to each internal component for both directions of operation.

If a pressurized lubrication system is required for the reducer, a redundant lubrication system shall be provided. The redundant system shall operate at all times when the primary system is functioning.

Inspection ports on gear reducers shall provide for inspection of all gears, bearings and other internal devices. The ports shall be located above the oil level, if practicable, so that oil draining is not required for inspection. The port shall be sized such that minor repairs could be made to gear boxes without requiring housing disassembly. Ports shall be properly sealed with seals that do not require replacement when ports are opened.

Reducers shall be furnished with moisture trap breathers, oil fills, breakproof glass oil level indicators, drains and inspections ports.

Moisture-trap breathers shall be located above maximum oil levels in all positions of the reducer during operation, and its piping shall enter the unit at the highest point possible. Breathers shall not be mounted in bearing caps.

Oil level indicators shall be mounted in locations that can be easily viewed by maintenance crews. On reducers in which the oil level varies by more than 12 mm per 10°C (0.47 in per 50°F)

temperature change, the sight glass shall be graduated. The indicator shall be vented back to the case. Sight glasses shall be of rugged construction and protected against breakage.

Oil drains shall be located at the lowest point possible. The drain shall have a hand operated lever which can be locked in the closed position.

Oil sampling cocks shall be located in accessible positions on the reducers. There shall be two sampling cocks, one located at the lowest level of oil and one just below the upper oil level.

Gear reducers shall have provisions for oil expansion due to churning and temperature change.

Reducer bearings, which are grease lubricated, shall be fitted with readily accessible grease fittings. Internal seals between the bearing housing and the gear oil shall prevent interaction between them.
On shaft extensions, bearing shaft ring seals shall be mechanical type oil seals, which compensate for wear. Dual lip spring loaded seals are preferred.

On open-ended lower bearings of vertical shafts, extra precaution must be taken to prevent oil leakage. A dry-well arrangement in which the bearing is isolated from the oil bath is preferred. Grease lubrication of the lower bearing is required in these applications.

Shaft extensions for the various reducers shall be of the arrangement, lengths, and diameters shown on the drawings. Couplings shall be pressed on the shafts in the shop.

The manufacturer shall submit for approval a certified print of each speed reducer showing as a minimum the following:

All external mounting dimensions including shaft sizes, bores, and keyways where required.

Internal drawings showing each gearbox component with part numbers.

The ratings that will appear on the nameplate.

Location of all lubricant connections.

Lubrication recommendations.

The manufacturer shall submit for approval by the Engineer computerized calculations showing conformity to the requirements of the AGMA Standard Practice specified. The reducer design calculations must be made available to the Department prior to construction of the unit.

Reducer bases shall extend past the body of the reducers to allow for mounting bolt hole reaming and bolts installation from above the unit.

The speed reducer will be by Prager Gear Corporation, New Orleans, Louisiana; The Falk Corporation, Milwaukee, Wisconsin; Horsberg and Scott, Cleveland, Ohio.

2. Rack and Pinion Gears

For each bridge, the new rack pinions shall have an FN2 fit to their respective shafts with keys and keyways as shown on the plans. All keyways are to be machine cut and the centerline of the keyway shall align with the centerline of one of the pinion gear teeth.
The gears shall have the following characteristics:

	Ingersoll	**Washington**
Pinion Gear		
# Teeth	10	10
Pitch Diameter	254.0 mm	254.0 mm
C.P.	79.8	79.8
Face Width	120.7 mm	152.4 mm
AGMA Quality #	7	7
Material	ASTM A668M, Class K	ASTM A668M, Class K
BNH	250-290	250-290
Rack Gear		
# Teeth	74	59
C.P.	79.8	79.8
Face Width	127 mm	155.6 mm
AGMA Quality #	6	6
Material	ASTM A668M, Class K	ASTM A668M, Class K
BNH	207-269	BNH 207-269

Spur gears shall have a 20-degree pressure angle, full-depth, involute cut teeth in accordance with the proportions of ANSI/AMGA 201.02, Tooth Proportions for Coarse-Pitch Involute Spur Gears, unless otherwise specified herein or shown on the plans.

The teeth of all gears shall be cut from solid rims or blanks. The sides and peripheries of all gears and pinions shall be finished; the pitch circle shall be scribed on both sides not less than 0.5 mm (0.02 in) deep with a V-pointed tool. The working surfaces of all gear teeth shall be true to the proper outline, accurately spaced on the true pitch circle, exceptionally smooth, and free from planning or milling cutter edges. Cutter burrs shall be removed from all edges of the teeth, and the top edges of all teeth shall be rounded to a 0.8 mm (0.03 in) radius.

Except as otherwise provided herein or on the drawings, all gears shall be cut and mounted to meet the requirements for accuracy of AGMA Standard 390.02, AGMA Gear Classification Manual. The AGMA quality number shall be stated on the applicable shop drawings. Open gearing shall conform to AGMA Quality No. 6.

3. Shafts

The pinion shafts at Ingersoll and Washington Street will be fabricated from ASTM A668M, Class D alloy steel.

The skew and balance shafts shall be fabricated from ANSI 1045 material. Machined keyways shall be provided as shown on the plans.
All shafts and pins shall be accurately finished, round, smooth, and straight and, when turned to different diameters, shall have rounded fillets at the shoulders. Each shaft or pin having a uniform diameter of 200 mm (7.87 in) or more and each shaft or pin having several diameters, of which the smallest is 200 mm (7.87 in) or more, shall be bored lengthwise through the center to diameter approximately one-fifth the smallest body diameter.

All shafts shall conform to tolerances in ASTM A29 unless otherwise indicated. Turned, ground and polished shafting straightness tolerances shall be 0.167 mm/m (0.002 in/ft) for shafts up to and including 38 mm (1.5 in) diameter and 0.25 mm/m (0.003 in/ft) for shafts over 38 mm (1.5 in) in diameter.

Each end of all shafts, when finished to the required lengths shall have 60 degree lathe center, with clearance hole, at the exact center of the shaft. Shafts that are bored with an inspection hole shall have the end prepared for the attachment of a centering device equivalent to the lath center. All such devices shall be furnished as part of the work.

Where shown on the drawings, stepped shafts shall have fillets blended smoothly to adjacent surfaces without tool marks or scratches. Unless otherwise required herein or on the drawings to have a finer finish, the surfaces shall have an ANSI maximum roughness of 0.40 micrometers.

All cold-finished shafting shall be steel of the type and grade shown on the drawings and shall be tested for its mechanical properties, and a test certificate shall be furnished to the Engineer. Each cold-finished shaft shall be free from camber and shall run without vibration, noise, or chatter at all speeds up to and including the maximum rated speed.

All hubs mounted on the ends of cold-finished shafts shall have the fit specified herein or on the drawings. To obtain the required fit between hub and shaft, the Contractor shall furnish the cold-finished shaft 1.5 mm (0.060 in) larger than the nominal diameter specified and shall turn the ends to the required dimension for the hub. The Contractor may, at his option, furnish any cold-finished shaft of one diameter end to end; but such shaft shall have tolerances selected from the normal manufacturing range to provide the specified fit. The selected tolerances shall be shown on the shop drawings.

Turned, ground, and polished commercial shafting of the grade specified shall be used where shown on the drawings.

5. Spherical Roller Bearings

The bearings for the pinion and guide roller shafts shall be self aligning spherical roller bearings. Spherical roller bearings shall be mounted in cast steel pillow block housing. The housing shall have a removable cap attached with high strength bolts and locating pins. The housings shall have undersized mounting holes, such that the holes will require drilling and reaming at installation. Slotted holes are not allowed and shall be grounds for rejection. The bearings shall be lubricated with grease as per the manufacturer's recommendations. The bearing manufacturer shall review the Contractor's shop drawings prior to submission to the Engineer for review. Heavy duty seals shall be included. All lubrication fittings shall be of easy access. The load ratings are expressed in KG which equal 1000 grams. The bearings shall have a rated B-10 life of 40,000 hours.

Manufacturers of Spherical Roller Bearings are: Torrington Company, Torrington CT; SKF Bearings, King of Prussia, PA; Meither Bearing, and Odessa, TX.

	Ingersoll	**Washington**
Pinion Shafts:		
Bearing Designation	Bearing B2	Bearing B2
Housing Type	Cast Steel Pillow Block	Cast Steel Pillow Block
Bore	125.4 mm	125.4 mm
Basic Static Capacity	5819 kg	5819 kg
Basic Dynamic Capacity	870 kg	870 kg
Full Speed	670 rpm	670 rpm
Guide Roller Shafts:		
Bearing Designation	Bearing B3	Bearing B3
Housing Type	Cast Steel Pillow Block	Cast Steel Pillow Block
Bore	63.5 mm	80.9 mm
Basic Static Capacity	997 kg	8709 kg
Basic Dynamic Capacity	149 kg	1306 kg
Full Speed	9 rpm	9 rpm

6. Flexible Couplings

Coupling hubs shall be bored by the coupling manufacturer to the required size and tolerances, including keyways, and each hub shipped to the proper location for installation on its shaft by the manufacturer of the connected component. All coupling hubs with interference fits shall be provided with tapped holes of sufficient size for a means of removal from the shafts. Manufacturers of Flexible Couplings are: Lovejoy Inc., Downers Grove, IL, Browning Manufacturing Division of Emerson Power, Maysville, KY, Dodge – Reliance, Mishawaka, IN.

7. Gear Couplings

Gear couplings shall be provided as shown on the plans and described herein. Each coupling shall consist of two geared hubs connected by a matched pair of geared sleeves with bolted flanges. Each coupling shall be capable of accommodating both offset and angular misalignment. Gaskets and seals shall be employed to make the coupling dust and moisture proof and oil tight. Each coupling shall be provided with pressure type lube fittings in the geared sleeves and the coupling flanges shall have shrouded bolts. Each hub shall be shipped to the manufacturer of the equipment upon which it is to be mounted. Each shall be bored, finished and installed on its shaft in the shop to provide a slight interference fit according to the coupling manufacturer's recommendations, subject to approval by the Engineer. Properly sized keys of ASTM A668M, Class K material shall be furnished. Manufacturers of Flexible Couplings are: Manufacturers of Flexible Couplings are: Falk Corporation, Milwaukee, WI, Kop-Flex, Incorporated, Baltimore, MD, Sier-Bath Gear Company, Inc., North Bergen, NJ.

8. Grid Couplings

Grid type, self-aligning, fully flexible, torsionally flexible couplings shall be used to connect electric motors to machinery components. The grid type couplings shall have steel hubs, alloy

steel grids, and steel or aluminum coves. Bolts in the covers shall be shrouded. Couplings shall be the standard product of an established manufacturer. Properly sized keys of ASTM A668M, Class K material shall be furnished. Special couplings shall be as shown on the plans. These couplings shall be standard manufactured products by Falk Corporation, Milwaukee, WI, Browning Manufacturing Division of Emerson Power, Maysville, KY, Dodge – Reliance, Mishawaka, IN.

9. Thrust Rollers

Transverse thrust rollers, pins, and supports at both bridges shall be replaced. The new rollers shall be fabricated from AISI 1045 hot rolled alloy steel. The rollers shall be mounted in spherical roller bearings as shown on the plans prior to delivery to the job site.

10. Machinery Enclosures

The C1 and C2 couplings shall have enclosures. The enclosures shall be constructed from 10 gage stainless steel sheet, and shall be of welded construction. The enclosures shall have an inspection cover for easy access to lubrication ports and inspection of the couplings. All surfaces of the machinery enclosures which are to receive paint shall be roughened to a degree suitable for proper adhesion of the specified paint system. Minimum surface preparation shall be SSPC-SP 6, Commercial Blast Cleaning, in accordance with Item 573.1014nn18, Field Clean and Paint – Total Removal. The enclosures shall be painted safety orange and shall be removable for maintenance purposes.

11. Fasteners

Unless otherwise specified on the plans, or specified herein, set screws shall be of the headless safety type, shall have coarse threads and shall have cup points. Set screws shall neither be used to transmit torsion nor as the fastening or stop for any equipment that contributes to the stability or operation.

Anchor bolts connecting machinery parts to concrete shall be ASTM A307M, Grade A material, hot-dipped galvanized per ASTM A153. Bolts shall be shown on the drawings. Anchor bolts shall be either cast-in-place, or adhesive type and conform to the requirements of standard specifications 721-03 and 701-05. When these fasteners connect a mechanical component directly to the concrete, there must be a filler material in the annular area between the bolt and the bolt hole in the machinery component. The filler material shall be non-shrink grout, unless otherwise approved.

All bolts for connecting machinery parts to each other or to supporting members shall be ASTM A449 as shown on the plans or specified otherwise and shall conform to one of the following types: Finished body, high strength bolts; Turned bolts, turned cap screws, and turned studs; High strength turned bolts, turned cap screws and turned studs.

When assembled, all joined surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale, except tight mill scale, and shall also be free of dirt, loose scale, burrs and other foreign material and defects that would prevent solid seating of the parts.

All elements connected by bolts shall be drilled or reamed assembled to assure accurate alignment of the hole and accurate clearance over the entire length of the bolt within the specified limit.

Bolt holes through unfinished surfaces shall be spot faced for the head and nut, square with the axis of the hole.

Unless otherwise specified on the plans or herein, all bolt holes in machinery parts, which connect these parts to support steelwork, shall be sub-drilled at least 1mm smaller in diameter than the bolt diameter. The holes shall be reamed for the proper fit at assembly or at erection, only after correct assembly and alignment as completed and approved.

Holes in shims and fill plates for machinery parts shall be reamed or drilled to the same tolerances as the connected parts at final assembly.

Whenever possible, high strength turned bolts connecting machinery parts to structural parts or other machinery parts shall be inserted through the thinner element into the thicker element.

Turned bolts are bolts having a machined shank 2 mm larger in diameter than the threaded portion and shall be used to fasten all machinery parts to each other and to their supports. The fit between turned bolts and their holes shall be Class LC6. The holes shall be drilled and reamed at final assembly after proper alignment of all components has been satisfactorily achieved by the use of temporary bolts or clamps.

12. Keys

All keys shall be ASTM A668M, Class D alloy steel. Keys and keyways shall meet ANSI specifications. Parallel faced keys shall be used for keying machinery parts to the shafts, unless otherwise shown on the plans or specified herein. Mating keyways in hub and shaft must match and be parallel to the axis of the shaft. When keys are installed, they shall bear on sides with the fit specified on the plans, completely filling their seats. All keys that do not fulfill all of the above requirements shall be rejected at any stage of the work, and new keys, satisfactory to the Engineer, shall be furnished.

13. Shims

Shims shall be ASTM A240M stainless steel where specified. Shim packs are defined on the plans and will consist of several pieces of shim of varying thickness. Shim pieces shall be provided of the thickness required to align the various machinery parts to within the manufacturer's recommended tolerance. When two parts from different manufacturers are aligned, the more stringent tolerance shall govern.

14. Operating Ropes and Sheaves

All operating ropes shall be 19 mm (3/4 inch) galvanized 6 x 19 construction from improved plow steel. The ropes shall have galvanized, forged steel open spelter sockets at each end. The sockets shall meet the performance requirements of Federal Specification RR-S-550D, type A, and be factory assembled prior to shipment to the field. All rope assemblies shall be pre-stretched and shall have a finished length within 10 millimeters of that shown on the plans. The ropes shall

be shipped on reels having a minimum diameter of 25 times the rope diameter. The ropes shall have an ultimate strength of not less than 204.6 kN. One test piece shall be taken from the original coil from which each operating rope is fabricated. The length of each test piece shall be 50 times the nominal diameter of the rope to be tested. Each test piece shall be tested to destruction. The test report shall be provided to the Engineer for review. Test specimens which do not meet the specified strength requirement shall be rejected and a new specimen shall be prepared. If the second specimen fails to meet the strength requirements, the coils shall be rejected and all ropes fabricated from the coil shall be rejected.

Operating rope take up shall be manufacturer from ASTM A709M, Grade 250 material as shown on the plans.

The operating rods shall be manufactured from ASTM A709M, Grade 250 steel as shown on the plans.

New "B" sheave rims and hubs shall be fabricated from ASTM A668M Class D, spokes and gussets shall be fabricated from ASTM A709M, Grade 345 carbon steel as shown on the plans. The fabricated sheaves shall be stress relieved after welding and prior to final machining. All dimension shown on the plans are final dimensions, and do not make allowance for distortion due to welding. Upon completion of stress relief, the weldments shall be cleaned and inspected for any cracking (Dye Penetrant method). Any cracks shall be brought to the attention of the Engineer prior to any repairs. Unauthorized repairs shall be ground for outright rejection of the weldment.

The operating sheaves will be set on new shafts with new keeper plates and bolts to prevent shaft rotation. The new shafts will be ASTM A668M, Class D forged steel. The new keeper plates will be ASTM A709M, Grade 250 steel plate and new bolts will be ASTM A325M high strength bolts. The new bushings shall be ASTM B22M, Alloy 93700 cast bronze.

Operating sheave grooves shall be milled to provide the same nominal root diameters for each set. A tolerance of +0, -0.2 mm shall be maintained for each groove root diameter relative to all other operating sheaves root diameters in the set. A set shall consist of 12 sheaves. The root diameters shall be measured and recorded. The dimensions of each sheave within each set shall be provided to the Engineer.

15. Idlers

The operating rope rod idlers shall be refurbished, including cleaning, inspecting, machining and installation of bronze bushings with grease fittings, painting and replacement of shafts. The new shafts shall be ASTM A709M, Grade 250.

16. Lubrication Fittings and Piping:

Lubrication Fittings –Bearings and surfaces requiring grease lubrication, other than open gear teeth, shall be fitted for pressure lubrication using 0.25 inch NPT standard industrial button head lubrication fittings (such as Alemite No. A1186). Lubrication fittings shall be located to avoid accumulation of contaminants and shall be kept clog-free.

Piping – The fittings shall be connected to machinery by seamless brass pipe so that grease will be discharged directly into the component for distribution. Lubrication fittings shall be conveniently located for greasing. Use angle elbow bodies where necessary. Where indicated on plans, they shall be connected to the points requiring lubrication from convenient accessible lubrication stations by seamless brass pipe with cast bronze or brass fittings. Piping shall be securely supported and located so that it will be protected from damage or excessive vibration. Lubricating equipment shall be installed in a workmanlike manner.

Miscellaneous – Machinery components requiring oil lubrication shall be provided with means for filling, indication of level of lubricant, and draining. The drain connection shall be provided with a drain cock.

17. Tests at Plants of Manufacture

All tests at plants of manufacture shall be witnessed by the Engineer or certified by an approved testing agency at the option of the State. A minimum of three (3) weeks notice shall be provided to the Engineer prior to any scheduled testing.

Before shipment of a main speed reducer from the plant of manufacture, it shall be subjected to the following tests:

a. The inspection cover(s) shall be removed and all tooth surfaces shall be inspected.

b. Each shaft shall be checked for both radial and axial play at each end.

c. A no load spin test at rated RPM for two (2) hours in each direction. Bearing and lubricant temperatures shall be measured at 15 minute intervals.

d. A 100 percent full load test at rated RPM for one-half (1/2) hour in each direction, bearing and lubricant temperatures as well as sound levels shall be measured at 10 minute intervals during this test. In no circumstance shall the bearing or lubricant temperatures exceed 23° C above ambient during the test. The sound level shall not exceed 90 db above ambient during the test. Any readings of measured quantities exceeding the maximum allowable shall constitute failure and shall be grounds for rejection. All test shall be continuous, the load tests shall immediately follow the no load tests.

e. After the preceding tests have been completed, the inspection cover(s) shall be removed and all tooth surfaces shall be inspected for visible wear and misalignment. The radial and axial play shall be rechecked. The gears and keys shall be checked for looseness and the bearings and gear teeth shall be checked for presence of lubricant. The test lubricant shall be drained over a screen and all metal particles shall be retained and inspected by the Engineer.

Failure to comply with and successfully complete any of the above tests shall be cause for rejection.

All faults revealed during testing shall be corrected and the test in question redone at the Contractor's expense. The contract shall provide a final test report including all findings including photographs, test data sheets and anecdotal information.

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CONSTRUCTION DETAILS

1. Shop Drawings

Shop drawings for all components supplied under this item shall be required, and submitted to the Engineer for approval.

2. Removal of Existing Machinery

All existing machinery shall be removed without damage to the machinery or structure. All machinery shall remain the property of the NYS Canal Corporation and shall be either turned over to the Canal Corp. or disposed. Components of machinery to be turned over to the Canal Corp. shall be loaded on State trucks by the Contractor at the job site as arranged by the Engineer.

a. Main sheaves (Sheaves A)
b. Operating rope sheaves
c. Bearing housings
d. Span drive motors

All machinery not to be reused or turned over to the Canal Corp. shall be disposed of by the Contractor.

3. Installation of New Machinery

All new machinery shall be shop assembled to the greatest extent possible. The shop drawings shall indicate which items shall be shop assembled and which items shall be field assembled. Shop assembly does not relieve the contractor from assuring that all alignment specification requirements are met, at final assembly, in the field. All assembly shall be performed by millwrights with demonstrated skill in work of similar size and complexity. All tolerances for aligning the machinery shall be as recommended by the machinery manufacturer or as specified by the American Association of State Highway and Transportation Officials "Standard Specifications for Movable Highway Bridges," 2000 Edition, whichever is more stringent. No operating machinery, except the counterweight sheaves, shall be mounted until the counterweights and lift span are hung from their rehabilitated counterweight sheaves. The new rack segments shall be mounted to new lifting posts with turned bolts.

The lifting posts shall be verified to be vertical before mounting the rack segments. All rack mounting surfaces shall be milled flat to within 0.25 mm to a finish of 6.40 micrometers. The mounting holes in the new lifting post steel shall be field drilled and reamed to suit the turned bolts using the rack segments as templates. The rack segments shall be properly located, and the segment joints butted together before drilling any holes. Special care shall be taken to maintain the proper alignment and spacing of adjacent teeth between rack segments.

All rack pinion shafts shall be mounted in their rack pinion bearings such that the scribed pitch lines on both sides of a rack and rack pinion coincide and full face tooth engagement is achieved on both sides of the teeth. Both pinion gears shall be properly set to their respective racks with both backlash and tooth contact as shown on the plans prior to final drilling of the spacer for coupling C4 on Ingersoll Street Bridge and coupling C5 on Washington Street Bridge. Proper

tooth engagement, as described above, shall be maintained on both rack pinions for the full length of travel of the bridge. Proper tooth engagement shall be achieved before the permanent mounting of the rack pinion bearings. The pinion backlash shall be set to 2.54 mm +/- 0.254 mm. The tooth contact shall be a minimum of 80% as measured using bluing or other surface contact measurement techniques as approved by the Engineer. The rack pinion bearing mounting holes shall be drilled and reamed in the field to suit the turned bolts using the bearings in their final position as templates. The two rack pinion shafts for each bridge shall be coaxial such that a cross shaft may be installed without exceeding 50% of the manufacturer's permissible misalignment criteria of the cross shaft couplings.

The contractor shall field verify the location of all machinery prior to the installation of any machinery component.

4. Installation and Maintenance Manual

Installation and Maintenance Manuals for all components supplied under this item shall be prepared. These manuals shall be organized to include:

Installation Manuals shall indicate the method of installation for all major mechanical components. The manual will provide specific safety instructions regarding removal of components and will provide a list of required tools and equipment which may be required to effect the work. Installation tolerance and alignment requirements shall be provided. The manual will include a complete set of shop drawings as well as all catalog cuts and manufacturer information such as name of supplier, make and model number, local supplier or technical contact. The manual shall be organized into sections which represent the major system components (operating rope system, pinion and skew shafts, speed reducer, brakes and instrumentation).

Maintenance Manuals shall include a description of all maintenance and lubrication work to be performed including frequency. The maintenance tasks shall be clearly defined including tools, equipment, supplies and lubricants required. Drawings shall be included in this manual indicating all lubrication points, type of lubricant and frequency of lubrication required. All components which require replacement such as desiccant breathers, and seals shall be clearly indicated. A list of suppliers for all lubricants and consumable components shall be provided.

5. Lubrication

The Contractor shall prepare a lubrication chart which shall show all points requiring lubrication, the type of lubricant to be used at each point, and the frequency of lubrication. The lubrication chart shall include the wire ropes. The chart shall be submitted for approval as a shop drawing. The Contractor shall furnish three (3) copies of the approved chart, mounted in approved frames with glass covers, to be located where designated by the Engineer.

The type of lubrication fittings shall be standardized and shall be of the Medium Button Head Type. The Contractor shall provide a lever type gun with a three foot flexible hose per bridge. Each fitting shall be connected to the points requiring lubrication by pipe extensions where necessary. Fittings furnished on standard manufactured parts shall be replaced with fittings that have been selected as standard for the bridge.

During installation, the Contractor shall fully lubricate all parts of the machinery in accordance with the manufacturer's recommendation prior to operation, and maintain proper lubrication until final acceptance of the project.

The Contractor shall provide additional start-up lubricants for all machinery and wire ropes in quantities equal to those needed to fully lubricate the machinery and wire ropes per the manufacturer's recommendations.

The operating ropes shall be lubricated with wire rope dressing as recommended by the rope manufacturer for this specific application. The ropes shall be dressed at an interval recommended by the wire rope manufacturer. The final application of rope dressing shall be within two (2) weeks of the final turnover of the structure to the state at completion of the project.

6. On-Site Tests

All on-site tests shall be witnessed by the Engineer.

When the entire installation of a bridge is completed, the span, including all accessories, shall be operated through not less than three complete cycles using normal power, prime movers, and control. During these runs, the equipment shall be inspected to determine whether all features are in proper working order and adjustment, and meet the requirements of the Contract Documents to the satisfaction of the Engineer. The bridge shall be completely checked with recording type electrical instruments, and the temperature rise of electrical parts, due to the specified duration of continuous testing, shall not exceed design ratings. Should the tests show that any features are defective or inadequate, or function improperly, the Contractor shall make, at his own expense, all corrections, adjustments, and replacements required. The tests shall then be run again and this procedure repeated until the full complement of tests is successfully completed. The Ingersoll Street Bridge shall be tested with a load of 4413 kg placed concurrently at each end of its span to simulate wind and ice loads. The Washington Street Bridge shall be tested with a load of 4776 kg placed concurrently at each end of its span to simulate wind and ice loads. The total continuous duration of a bridge's operating cycles with its simulated wind and ice load shall be at least 30 minutes for its main drive system.

7. Operating Ropes

The operating ropes and rods shall be installed as shown on the plans with the lift span in the closed and seated position. The tension in each operating rope assembly shall be set to 450 kg. The tension shall be within five (5) percent of the specified value. All four operating rope assemblies shall have their tensions within five (5) percent maximum variation (highest to lowest tension). The ropes shall be installed without twist. Kinks, broken strands or corrosion in any wire rope shall be grounds for immediate rejection of the rope.

8. Protection for Shipment

All finished metal surfaces shall be coated as soon as practical after machining with a corrosion-inhibiting protective coating as approved by the Engineer.

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All parts shall be completely protected from weather, dirt, and foreign materials during manufacture and shipment, and shall be stored indoors in a clean, dry place while awaiting erection.

Tags recording the part number, in accordance with the approved shop drawings, shall be wired to each part prior to shipment. Mounting hardware and other small parts shall be bagged and crated for shipment.

9. Painting

All mechanical equipment and shafts shall receive three (3) shop applied coats of paint in accordance with the requirements for Standard Specification Section 572 – Structural Steel Paint System: Shop Applied. The cost of the shop painting shall be included in the price bid for this item.

No paint shall be applied to sections of the shaft which contact the bearings, bushings, couplings, keys, threaded surfaces and faces.

All rotating shafts and components shall be painted safety orange.

Field touch-up painting shall be performed upon completion of the shaft installation to any painted surfaces damaged during shipping and/or installation.

See Drawing BN-2 for further painting requirements.

METHOD OF MEASUREMENT

The work of this item will be measured as a lump sum unit of work per bridge.

BASIS OF PAYMENT

The lump sum price bid per bridge shall include the cost of all labor, material and equipment required to complete the work of this item.

Progress Payments will be authorized as a percentage of the lump sum price based upon the following schedule:

Ten percent (10%) of the lump sum price per bridge will be paid upon completion of removal of existing bridge machinery.

Fifty percent (50%) of the lump sum price per bridge will be paid upon delivery of bridge machinery to site.

Twenty percent (20%) of the lump sum price per bridge will be paid upon completion of installation of all machinery.

The remainder (20%) of the lump sum price per bridge will be paid upon completion of all bridge machinery work including delivery of approved manuals.

Payment will be made under:

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Item 599.06010104 M Bridge Operating Machinery – Ingersoll Street
Item 599.06010204 M Bridge Operating Machinery – Washington Street